

# Human Uses of Nuclear Science

Atoms for Peace Conference  
Lawrence Livermore National Laboratory  
November 14-15, 2003  
Martha Krebs

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# Where We Are Today

## □ Medicine

- Sterilization
- Drug Testing
- Diagnosis
- Therapy

## □ Agriculture

- Plants
- Animals
- Food Processing

## □ Industry

- Process Evaluation and Controls
- Materials Characterization

## □ Personal Care

## □ Public Safety

- Screening
  - Smoke Detectors
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# What's Notable About These Applications

- Evolutionary Not Disruptive
    - Remarkable progress that was essentially foreseen 25 years ago
  - Focuses inwardly on the contributions of knowledge about the properties of the nucleus
  - Addresses specific areas of technical practice
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# Enduring Basic Human Needs

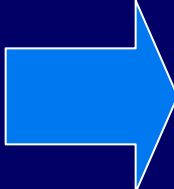
- ☐ Health
- ☐ Nutrition
- ☐ Shelter
- ☐ Family/Community
- ☐ Communication
- ☐ Security/Comfort
- ☐ Work
- ☐ Understanding

***Technology can both satisfy and disrupt these needs; Scientists and engineers should weigh their efforts within the framework of these needs and recognize their limitations.***

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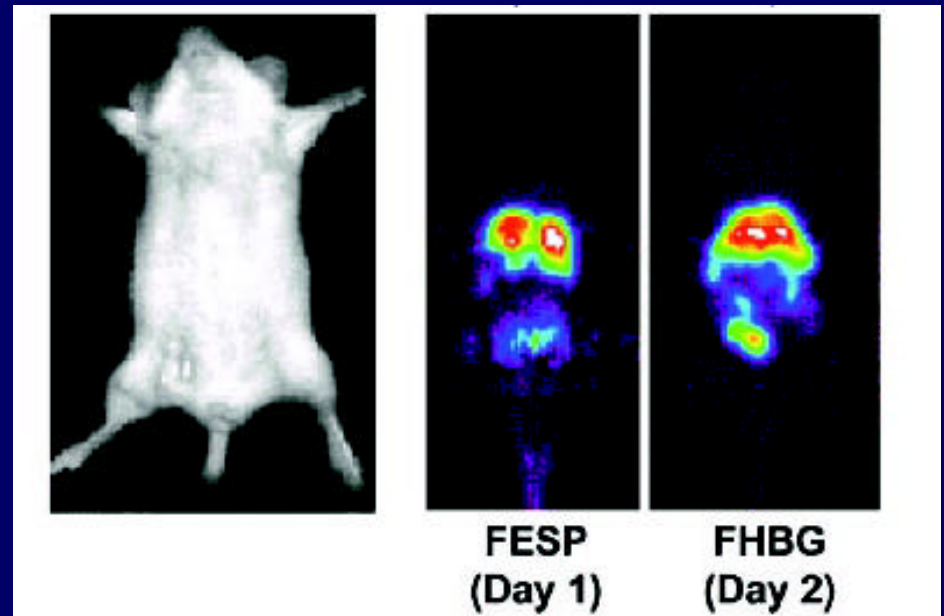


# Disruptive Science and Technology

- Characterization, Manipulation and Control at the Nanoscale
  - Quantum Phenomena at the Mesoscale
  - Complex Systems, Emergent Phenomena
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- Single Molecule Medicine
  - Quantum Communication and Computation
  - Autonomous, Networked Microagent Systems
  - Single Event Effects

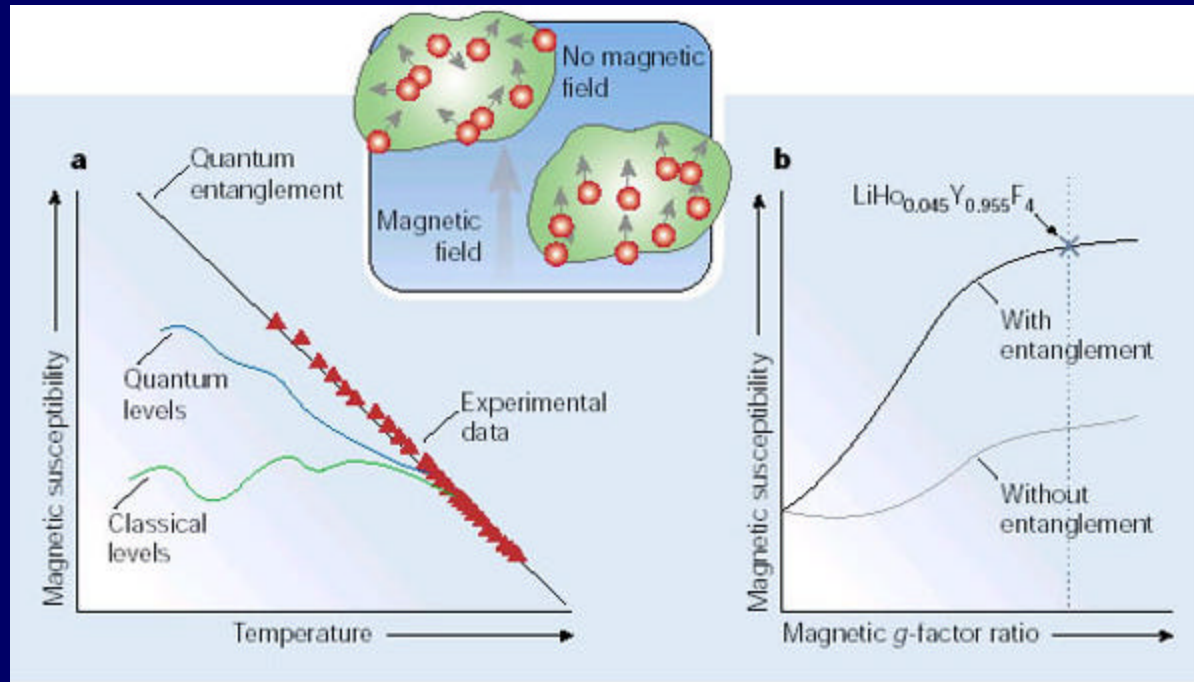
# Molecular Medicine

- Noninvasive assays will permit real-time monitoring and modification of targeted interventions and therapeutic strategies
- Molecular imaging will play a key role in drug discovery, development, and delivery at the preclinical level.
- New clinical applications of conventional imaging technologies are likely to play increasingly important roles, particularly in oncology.



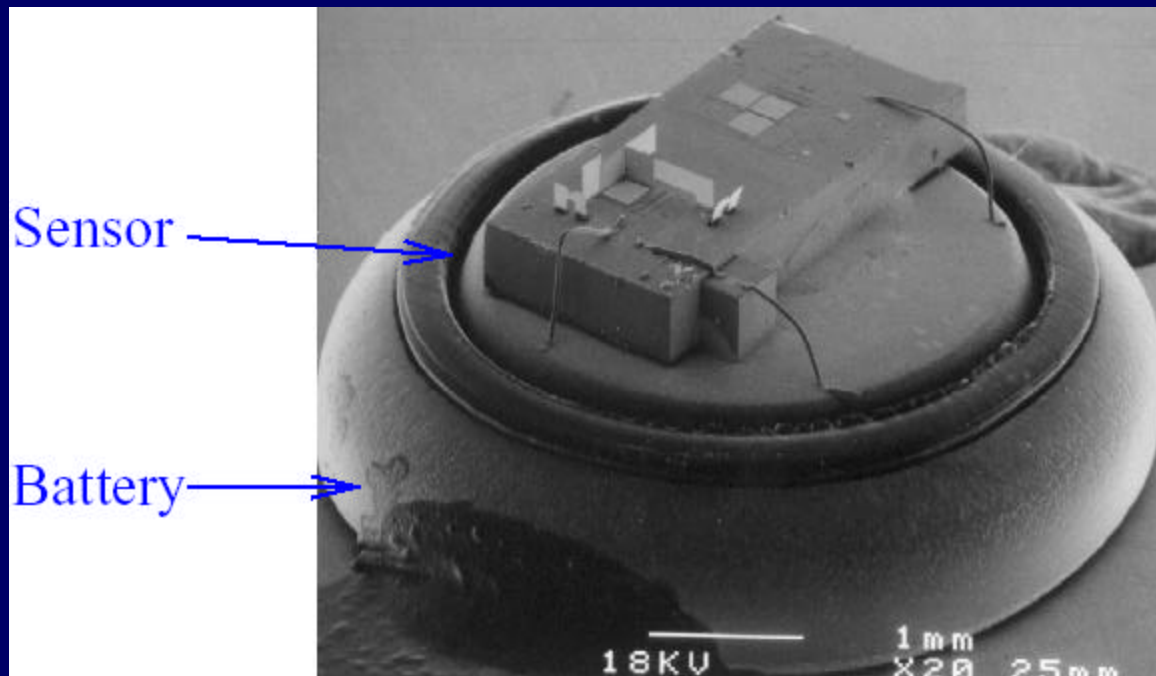
Harvey Herschman, Science, October 24, 2003, p.605

# Quantum entanglement accounts for bulk magnetic properties of $\text{LiHo}_{0.045}\text{Y}_{0.955}\text{F}_4$



**Entangled quantum state of magnetic dipoles**, S. GHOSH, T. F. ROSENBAUM, G. AEPPLI & S. N. COPPERSMITH *Nature* **425**, 48 - 51 (04 September 2003)

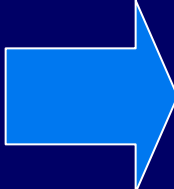
# Tiny Sensors Need Tiny Power Sources







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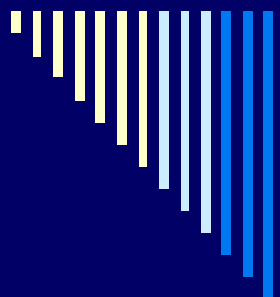
*How Will Nuclear Science Contribute?*



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# What's in the Future for Nuclear Science

- More Interaction with other disciplines
  - Nexus with the very small
  - Understanding Systems of Systems
  - Detection/Understanding of Single Events
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# Enduring Basic Human Needs

- Health
- Nutrition
- Shelter
- Family/Community
- Communication
- Work
- Security/Comfort
- Understanding

- Energy
- Rule of Law
- Democracy
- Environmental Quality
- Liberty
- Privacy
- Weapons

## *Derived Needs*

***Technology can both satisfy and disrupt these needs; Scientists and engineers should weigh their efforts within the framework of these needs and recognize their limitations.***